tail is so great that the theory is not closely knit with the facts. On the other hand, the preface is too compact for the reader to grasp fully the relations of theory and event. A final single volume which would combine the developmental theory with enough of the concrete history to give actuality would fittingly crown the largest and most capably executed piece of investigation in economic history which has been undertaken in our generation.

GEORGE E. BARNETT.

The Johns Hopkins University.

Hours of Work as Related to Output and Health of Workers. Wool Manufacturing. Research Report Number 12. (Boston: National Industrial Conference Board. December, 1918. Pp. 78. $1.00.)

"The purpose of the investigation is to establish the facts of this controversial subject and to present such conclusions as are clearly warranted by a scientific analysis of these established facts . . . to assemble the available results of actual experience . . . to determine the effect of reductions in work-hours on output and on health of workers" (p. vii and p. 1).

In the light of their own statement of purpose the authors should be judged. The order of treatment is as follows: (1) The statistical basis of the report; (2) the description of the general features of wool manufacturing, the chief processes and the hours of work; (3) a discussion of the hours and output of different groups of mills, according to hours worked and amount of reduction in hours, the largest group being the 54-hour group, in which there were 68 establishments, of which 55 reported a decreased output under the reduced schedule of working hours; (4) factors bearing on efficiency, such as size of mill, proportion of male workers, character of product, amount of reduction in hours, piece-work and day-work efficiency, speed of machinery, and attitude of workers; (5) actual statistical data as to output, and the difficulty of securing comparable data; (6) conclusions as to output; (7) the factors which affect the health of wool mill workers and conclusions as to the effect of the reduction of hours.

The data upon which the report is based were gathered by schedules of inquiry sent to the members of the National Association of Wool Manufacturers and other manufacturers, and by field investigation. Employers and workers were consulted and working conditions were observed. The *statistical basis* [italics

are mine] of the conclusions, the report informs us, consisted of replies to the schedule of inquiry from 111 establishments, employing 71,595 workers, supplemented by reports of field agents "who visited many mills." Here it should be stated that some detailed report of what the visitors actually did in their field investigation and how much time was devoted to an individual mill is needed. Any superficial observation of complex conditions is inadequate. Altogether the report covers 126 establishments in 13 states, almost one half of all the wool mill workers in the United States. Hours had been reduced in 85 establishments, with over 65,000 workers, in recent years and upon the reported results from these mills the conclusions rest.

Nowhere in the report do we find the exact form of the schedule sent to these mills—the specific questions the management of the mill was expected to answer, which is a grave defect in a scientific report; but the reader is told on page 3 that "*the information was in the form of statements reflecting the judgment of the respective manufacturers as based upon experience, and was in substantial accord with the results indicated by analysis of statistical comparisons of output* which were supplied by 13 of these establishments"[1] [italics my own]. The fact then seems to be that in only 13 out of 85 establishments, about 15 per cent of the total, are the conclusions based on actual statistical evidence and in these cases the data were furnished by the management of the mill. The authors of this report are hardly justified in speaking of the judgments of the other 85 per cent of the mills as statistical evidence at all for purposes of conclusions—"clearly warranted by a scientific analysis of the established facts" (their own statement of purpose).

The report frankly states the great difficulties in the way of securing comparable statistical data on output. There is manufactured a variety of products in a single mill. The weave and weight of the same product vary. Cotton warp is not comparable with woolen warp and the finish and weight may not run uniform over any considerable period. The speed of the loom is a variable factor and the yarn differs in size and material, all of which affects output when measured in pounds of yarn or yards of cloth. Moreover, the reduction of hours in over half the mills was made several years ago, and conditions have changed in the meantime.

[1] This last statement is to be questioned in view of the facts presented later in this review.

Besides, some mills now keep careful output records but did not do so before hours were reduced. A superintendent describes the factors that influence output directly or indirectly as "almost infinite." The president of one mill declares that "at least 90 per cent of the difference between the output of two weavers is due to the individuals themselves." The difference between high and low individual efficiency was reported as much as 30 per cent in some cases. As a result, the piece-workers more often than time-workers maintained output under a reduced schedule of hours of work. War conditions affected seriously the labor situation in the mills and thus influenced output.

Yet, notwithstanding the above and other difficulties and the fact that only 15 per cent of the mills actually submitted statistical data in support of their statements, the report declares that the conclusion is valid that "the 54-hour week has unquestionably placed a burden on the industry from a production standpoint." Furthermore, "the problem is by its very nature distinct from a problem in the so-called exact sciences." But statistics is an exact science which deals with numerical statements. Such statements were submitted from 13 mills and the results do not appear to be consistent with those obtained from the mere statements by the management, as shown in the table below. The authors admit the value of control experiments in the factory but fear that the worker may influence the result by conscious effort and they believe that "such experiments can be considered only as supplemental to experience as recorded under conditions as they actually occur in the factory." But the report itself has described these actual conditions so varied in the mill that it would seem a hazardous scientific procedure to depend upon "statements reflecting the judgment of the respective manufacturers as based upon experience" in so large a proportion of the total establishments reporting. In fact some experimental control of variable factors would seem the only way really to understand "conditions as they actually occur in the factory." Is it not the purpose of research in business to find ways of making business facts more exact and has not increasing precision attended these efforts in many fields? These precise measurements have actually been made in the very field covered by this report. A monograph, entitled *Use of Factory Statistics for the Investigation of Industrial Fatigue: A Manual for Field Research,* by P. S. Florence (Columbia University, New York, 1918), discusses in detail the difficulties and the practical procedure.

Furthermore, the Ministry of Munitions in England and the Sub-Committee on Fatigue under the Advisory Commission of the Council of National Defense for the United States have made such investigations, and have published or are about to publish valuable results. Other studies of this character are outlined in the text and excellent bibliography of a recent book by Frederic S. Lee, *The Human Machine and Industrial Efficiency*, (Longmans, Green & Co., 1918). The reviewer offers in evidence these studies in order to show that the matter under discussion is capable of exact measurement and analysis. The report says that "precise data, however, are not necessary" (p. 45). Perhaps not, to indicate some change in output, but that is not an explanation of why this change took place.

In the 54-hour group of mills 11 of the 68 mills furnished statistical comparisons of output compiled from book records while the remainder of the mills merely sent statements. The following table compiled from the facts stated on page 44 will summarize the situation:

NUMBER OF MILLS REPORTING SITUATION AS TO OUTPUT UNDER MODERN SCHEDULE OF HOURS REDUCED TO 54 PER WEEK.[1]

Output increased, maintained, or decreased in varying degrees	Total establishments under 54-hr. schedule	Eleven mills which submitted statistics from book records	Fifty-seven mills reporting by mere statement of the management
I Output increased	6	5	1
II Output maintained	7	–	7
III Output decreased but not proportional to time reduction	17	3	14
IV Output decreased in proportion to time reduction	26	2	24
V Output decreased more than proportional to time reduction	5	1	4
VI Not reporting amount of decrease	7	–	7
Total	68	11	57

[1] A total of 68 establishments, 11 of which submitted statistics from book records.

The reviewer recalls the statement (page 3 of the report) previously quoted, that "the information was in the form of statements reflecting the judgment of the respective manufacturers as based upon experience, and was in substantial accord with the re-

sults indicated by analysis of statistical comparisons of output which were supplied by 13 of these establishments." Eleven of these 13 are tabulated above and a glance will show that they contradict the statements from the other 57 who answered, not by statistics, but by statement. Only 8 of the latter, out of the 57, reported increased or maintained output, whereas 5 out of 11 offered statistical evidence of increased output. But if the 11 submitting the statistical evidence are representative, then a like proportion of increased or maintained outputs might be expected to appear among the statements of the other 57. Instead of the ratio of 5 to 11, the facts show 8 out of 57. Likewise, whereas 24 out of 57, reporting by statement, showed a decrease of output in proportion to decreased hours, only 2 out of 11 showed this situation where the actual book records were submitted. Seven out of 68 were positive in statement as to decreased output but did not attempt to state the amount. Further, on the same page, it is asserted that the mills where output was increased or maintained were chiefly the older and smaller mills. [Note that these were the mills furnishing the statistical evidence from their books.] And elsewhere the report accounts for this fact by the opinion that the larger and more modern mills, supplying the bulk of the trade, were already better organized before the reduction of hours and therefore after the reduction in working time could not maintain output by improvement in organization. Does it seem reasonable that, if these older and smaller mills were really less well organized, they could furnish statistical comparisons of output records from their books before and after the reduction of hours more easily than the better organized? Is it not likely that the larger and more modern mills, which reported in the main by statements of the managements instead of actual statistical facts from the records, were affected by a greater variety of variable factors described in this report, and, therefore, did not attempt to furnish statistical records to show comparative actual conditions of output. Then, is not the evidence for decreased output, for the most part, *ex parte* statements of a non-statistical character? General judgments and opinion evidence are of less value the more complex the variable factors involved. A single research authority must be the judge of the value of the evidence and not many individual mill executives.

On the matter of wage adjustments to compensate reduced working time and the effect upon output, the report, in Appendix A,

gives the answers received from the individual establishments. There is a very uniform report of "proportional increase" in wages, whatever this very vague statement may mean. Over what time did this "proportional increase" take place? Was it made to compensate for reduced hours as a stimulus to production or was it in response to the higher cost of living from 1912 to 1917? The report records the conclusion that "no clear relationship between changes in wages and changes in output, when hours of work were reduced, was indicated."

Now as to the second purpose of the report, to record the effect of the reduction of hours on the health of the worker, the evidence "suggests on the whole only unimportant changes—improvement in only a small number of cases." These conclusions are again based on *ex parte* opinion evidence and not on statistical evidence, as shown in Appendix A. There are no adequate records of sickness and reasons for absence from work. The following samples of reports on health changes are cited as given in Appendix A: "no difference," "good effect," "about the same, possibly a trifle better," "very little sickness," "health is good as it has always been," "health just as good with longer hours as with shorter." This evidence obviously has no scientific value.

The report gives the reader many interesting facts about woolen manufacture and the variety of factors affecting output and health, but its conclusions are based upon statements of opinion which, in the reviewer's opinion, are not adequately supported by statistical data of an unquestionably representative character. (Statistical data from some half dozen mills are published in some detail in the report.) The purpose stated in the beginning by the authors has not been attained. "The facts of this controversial subject" have not been established. The subject is left no less controversial. It follows that complete "scientific analysis" is impossible without the facts. Records of experience have been assembled to a very limited extent and nothing positive has been established as to health.

The writer wishes to see research of this character perfected and useful but he doubts the value of the *questionnaire* method in securing the evidence. It does not inspire confidence in the accuracy of the results and the method is entirely inadequate to cope with a complex factory organization with a great number of varying factors entering into any given result. Besides, the employer and his agents are interested parties and on this account

the records and results must be guarded from possible bias. This cannot be done in complex factory statistics by means of the *questionnaire* method of inquiry, but it can be done and is being done by the much more difficult and more scientific procedure of analysis of factory records, which are either available now or could be made available for industrial experimentation.

ROBERT E. CHADDOCK.

Columbia University.

The Human Machine and Industrial Efficiency. By FREDERIC S. LEE. (New York: Longmans, Green and Company. 1918. Pp. 119. $1.10.)

The trade-union slogan of a fair day's pay for a fair day's work has always been difficult to apply both as to time and as to wages. The result has been guessing at half and multiplying by two. Often the waste of human material in putting a man at the wrong job has been great. Professor Lee in this volume proposes a science of industrial physiology based upon the facts of present-day industry. The experience of Great Britain in the war munitions factories has been largely drawn upon. The activity of the human body, which plays so large a part in industry, must be organized on a physiological basis before the highest degree of efficiency can be secured. In other words, a science of the human machine must be developed in industrial establishments through observation and experiment.

Most of the substance of the book was given in two lectures at the Harvard Medical School and is now presented in seventeen short chapters on what may be called the use of human machinery without which mechanical machinery is of little value. Certain fundamental conditions of coördination between the worker and his work must be observed. These include the following:

1. Workers should be qualified for the work that they are to do.
2. Workers should produce a daily output in accordance with their individual capacities for work.
3. Workers should maintain their working power from day to day and from week to week.
4. Workers, once they have proved competent, should be retained.

Most of these points are merely axiomatic; the difficulty has been to translate them into actual practice. Professor Lee brings out clearly the various tests for vocational fitness, although, as he says, these methods are not very exact as yet. Fatigue is per-